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Factors and Frackers: A Look into the Scientific Methods Used by the EPA to Study and Assess Air Pollution from the Shale Oil and Gas Industry, and Some Proposed Solutions

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I. INTRODUCTION

The problem of industrial air pollution is as old as the industrial revolution. The United States Environmental Protection Agency

("EPA") was created with a view of providing a cleaner and healthier environment.[1] In order to fulfill this objective, one logical approach would have the EPA gather as much information as possible about air pollution, and monitor air emissions near locations known for or suspected of potentially emitting pollutants in the air. Further, when a new industry is developing and is not well known, the gathering of information and monitoring of air emissions should be emphasized so as to obtain a knowledge as complete as possible of such an emerging industry. However, the EPA largely lacks or has only been able to obtain limited air emissions data[2] related to the recently booming shale oil and natural gas production sectors. This article will examine the extent to which such lack of or limited data hinders the EPA's ability to effectively monitor, regulate, and enforce air emissions on a federal level, and propose solutions that may not be obvious by looking into the issue from a perspective stemming from science.

II. AIR POLLUTION FROM THE SHALE OIL AND GAS INDUSTRY

A. *What is shale gas and how is it obtained?*

The United States energy industry has recently experienced an enormous economic growth because of the convergence of two factors: the large amount of unconventional recoverable natural shale oil and gas reserves on its territory (estimated as 1,744 trillion cubic feet),[3] and the technological advances that have made shale gas recovery possible, namely the combined use of hydraulic fracturing and horizontal drilling.[4] Numerous shale basins containing both oil and natural gas deposits are spread throughout the continental

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1. *See* 42 U.S.C. § 4321 (1969).
2. *See EPA Needs to Improve Air Emissions Data for the Oil and Natural Gas Production Sectors*, U.S. ENVTL. PROT. AGENCY 20 (2013), *available at* https://www.epa.gov/sites/production/files/2015-09/documents/20130220-13-p-0161.pdf [hereinafter *EPA Needs to Improve Air Emissions Data*].
3. GROUND WATER PROT. COUNCIL, U.S. DEP'T OF ENERGY, MODERN SHALE GAS DEVELOPMENT IN THE UNITED STATES: A PRIMER 17 (2009), *available* at http://energy.gov/fe/downloads/modern-shale-gas-development-united-states-primer [hereinafter MODERN SHALE GAS: A PRIMER].
4. *See generally* Michael Q. Morton, Unlocking the Earth—A Short History of Hydraulic Fracturing, GEOEXPRO, Dec. 2013, at 86.

United States.[5] The extraction of this shale oil or gas[6] could provide enough energy to meet this country's needs for the next "90 years with some estimates extending the supply to 116."[7] These shale oil and gas deposits result from the progressive aneaerobic degradation of organic material derived from algae, plant, and animal products that accumulated within such shale rock formations.[8] The extraction of this shale oil and gas has only been possible recently due to the combined use of two relatively recent technologies: hydraulic fracking and horizontal drilling.[9]

The process of hydraulic fracking (also referred to as "fracturing") is commonly used to harvest the shale oil and gas trapped in shale deposits.[10] This process involves the injection of pressurized fluids containing a combination of water, proppant, and various chemical additives to create fractures within the shale rock formation.[11] For the most part, the oil and gas industry maintains the formulation, including composition and amounts, of the fracking fluids it uses as trade secrets.[12] In order to extract shale oil and gas, hydraulic fracturing is typically "combined with horizontal drilling,"[13] which is the process of drilling a well that starts as a vertical borehole from the surface to a desired kick off point above the shale oil or gas reservoir, at which point the well continues in an arc-shaped direction

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5. *See* U.S. Energy Information Administration, *Lower 48 States Shale Plays* (2011), http://www.eia.gov/oil_gas/rpd/shale_gas.pdf.

6. *See* R. A. Field et al., *Air Quality Concerns of Unconventional Oil & Natural Gas Production*, 16 ENVTL. SCI. PROCESSES & IMPACTS 954, 955 (2014). The production of oil or gas results in a range of products including methane (gas) to heavy hydrocarbons (oil); the denomination of such wells is based on which product is predominant. *See id.*

7. David M. Kargbo et al., *Natural Gas Plays in the Marcellus Shale: Challenges and Potential Opportunities*, 44 ENVTL. SCI. & TECH. 5679, 5679 (2010). This projection is limited to current production capacities and it should be noted that increases in production are planned, which would reduce the estimated timeline of a hundred years accordingly. *See* MODERN SHALE GAS: A PRIMER, *supra* note 3, at 8.

8. *See* Kargbo et al., *supra* note 7; *see also* MODERN SHALE GAS: A PRIMER, *supra* note 3, at 14 (explaining that shale is a sedimentary rock made of fine-grained clay particles deposited from tidal flats and deep water basins, which are further compacted by additional sedimentary deposition, such that the resulting compaction pressure forms thin layers of deposits that solidifies into shale rock).

9. *See* Morton, *supra* note 4, at 87.

10. *See id.* at 86; MODERN SHALE GAS: A PRIMER, *supra* note 3, at 46.

11. *See* Inessa Abayev, *Hydraulic Fracturing Wastewater: Making the Case for Treating the Environmentally Condemned,* 24 FORDHAM ENVTL. L. REV. 275, 294–96 (2013) (describing that the proppant of the fracking fluid is mainly made of granular sand that "hold[s] or 'prop[s]' open the . . . gas-filled pockets . . . within the shale rock formation, and prevent[s] them from closing during the natural gas recovery[,]" and that the chemical additives component of the fracking fluid comprises relatively safe chemicals such as polyacrylamide or guar gum as well as compounds known for being toxic or carcinogenic such as ethylene glycol or glutaraldehyde).

12. *See* Jeremy I. Maynard, *Fracking the Oil and Gas Trade Secrets of the Marcellus Shale Natural Gas Play*, 6 KY. J. EQUINE, AGRIC. & NAT. RESOURCES L. 161, 163 (2014).

13. Morton, *supra* note 4, at 87.

until it becomes almost horizontal, where it sits within the shale reservoir.[14]

The combined use of both horizontal drilling and hydraulic fracking is relatively recent and has driven the shale oil and gas industry to enormous technological and economic achievements.[15] However, it has been "controversial," with most of the controversy directed to the potential environmental impact of these processes on the quality of groundwater.[16] However, air pollution, which is more difficult to identify,[17] is also an important environmental consequence and health concern of the recent growth of the shale oil and gas industry.[18] For example, people living near shale oil and gas waste facilities in Texas and Utah have reported health problems including headaches and nausea.[19]

B. *The stages of development of the oil and gas shale industry and their potential effects on air quality*

The cycle of exploration and production of shale oil and gas involves several stages, including: (1) the development of shale oil and gas production sites and drilling of wells; (2) the extraction and processing of shale oil and gas; (3) the transportation, storage, and distribution of shale oil and gas; (4) the shale oil and gas end-use; and (5) the well production end of life.[20] Each stage may involve different air emissions sources and different atmospheric emissions, which can impact air quality.[21] In the early development stage as well as the transportation stage of gas well operations, atmospheric emissions may come from vehicles used to transport material and equipment.[22] These emissions are generally directly linked to the combustion of diesel fuels and include nitrogen oxides and volatile

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14. *See* Keith B. Hall, *Hydraulic Fracturing and the Baseline Testing of Groundwater,* 48 U. RICH. L. REV. 857, 863–65 (2014); *see also* Brian J. Smith, *Fracing the Environment?: An Examination of the Effects and Regulation of Hydraulic Fracturing,* 18 TEX. WESLEYAN L. REV. 129, 129 (2011).

15. *See id.*; *see also* Melody M. Bomgardner, *Cleaner Fracking,* CHEMICAL & ENGINEERING NEWS, Oct. 15, 2012, at 13.

16. Hall, *supra* note 14, at 857.

17. *See* Annmarie G. Carlton et al., *The Data Gap: Can a Lack of Monitors Obscure Loss of Clean Air Act Benefits in Fracking Areas?*, 48 ENVTL. SCI. & TECH. 893, 893 (2014).

18. *See* Kargbo et al., *supra* note 7, at 5681–82.

19. *See* David Hasemyer et al., *Fracking Sludge in Open Pits Goes Unmonitored as Health Worries Mount,* SCI. AM. (Oct. 2, 2014), http://www.scientificamerican.com/article/fracking-sludge-in-open-pits-goes-unmonitored-as-health-worries-mount-video/.

20. *See* Christopher W. Moore et al., *Air Impacts of Increased Natural Gas Acquisition, Processing, and Use: A Critical Review*, 48 ENVTL. SCI. & TECH. 8349, 8350 (2014).

21. *See id.*; *see also* MODERN SHALE GAS: A PRIMER, *supra* note 3, at 72.

22. *See also* MODERN SHALE GAS: A PRIMER, *supra* note 3, at 72–74.

organic compounds ("VOC"), which are both ozone precursors,[23] as well as carbon monoxide, sulfur dioxide, fine particulate matter, and toxic gases such as benzene, toluene, ethylbenzene, and xylene (also known as "BTEX").[24] All these compounds have toxicity and carcinogenic potential upon long term exposure.[25] During the well drilling phase, some of the gases trapped underground may vent or flare into the atmosphere before the well can be properly connected to the production lines.[26] Such gases are usually a mixture of hydrocarbons, including BTEX, VOC, and methane.[27] During the production of shale gas, atmospheric emission may result from the diesel-powered pumps, which are often used to provide the high pressure needed to pump fracking fluid in the well.[28] The gases emitted from these pumps are generally nitrogen oxides and VOC.[29]

In addition, fugitive emissions[30] are possible. Some fugitive emissions may originate from small leaks in the piping connections or pumping equipment resulting in emissions of natural gas and VOC into the atmosphere,[31] while other fugitive emissions may result from the inadvertent emissions of natural gas or VOC through fractures in the earth's surface.[32] Fugitive emissions, including those which may be produced during each processing and distribution stage of shale gas production,[33] are especially difficult to measure and contain.[34]

Finally, drilling water-based fluids are "important but uncertain emission[s] source[s]."[35] According to certain estimations, after

23. *See id.* at 73 (explaining that ozone is formed in the atmosphere through chemical reactions of nitrogen oxide and VOC in the presence of sunlight).

24. *See id.* at 72–73.

25. *See id.*; *see also* Moore et al., *supra* note 20, at 8352 (explaining how exposure to air pollutants such as BTEX, sulfur dioxide, and fine particulate matter has been linked to adverse health effects including respiratory and cardiovascular disorders).

26. *See* MODERN SHALE GAS: A PRIMER, *supra* note 3, at 72.

27. *See id.*

28. *See id.*

29. *See id.*

30. *See Fact Sheet—Prevention of Significant Deterioration (PSD) and Nonattainment New Source Review (NSR): Reconsideration of the Inclusion of Fugitive Emissions*, U.S. ENVTL. PROT. AGENCY (Oct. 8, 2014), https://yosemite.epa.gov/opei/rulegate.nsf/byrin/2060-aq47#5. Fugitive emissions are inadvertent emissions, which may come from many sources: from leaks or unintended release of shale gas, or from the evaporation of fracking fluids or waste, for example. *See* Field et al., *supra* note 6, at 956.

31. *See* MODERN SHALE GAS: A PRIMER, *supra* note 3, at 72.

32. *See* Field et al., *supra* note 6, at 956.

33. *See id.*; MODERN SHALE GAS: A PRIMER, *supra* note 3, at 72.

34. *See* Field et al., *supra* note 6, at 956.

35. *See id.*

their use in fracking wells, only twenty to forty percent of these fluids come back to the surface as flow-back fluids.[36] These flow-back fluids, which may contain BTEX and VOC as well as other unknown, trade secret chemical additives, are often stored, post-processing, in evaporation ponds or pits, which are not usually sealed, and thus may result in atmospheric emissions of pollutants.[37] Many of the chemicals used in the fracking fluids are "carcinogenic or associated with many problems affecting the eyes, skin, lungs, intestines, liver, brain, and nervous system," as well as other potential health issues including respiratory problems and birth defects.[38] However, according to one scholar, scientists have not been able to study in enough detail the health effects resulting from the air emissions caused by the development of the fracking industry.[39]

III. THE CURRENT RULES REGULATING AIR EMISSIONS FROM THE FRACKING INDUSTRY

A. *Local, statewide, and federal regulations*

The Clean Air Act ("CAA") amendments of 1970 were enacted by Congress to improve air quality by regulating new sources of harmful atmospheric emissions.[40] Under Section 108 of the CAA, the

36. *See* Morgan R. Whitacre, *An Environmentally Hazardous Process: Why the United States Should Follow France's Lead and Ban Hydraulic Fracturing*, 23 IND. INT'L & COMP. L. REV. 335, 343 (2013).

37. *See id.*

38. *See* Kargbo et al., *supra* note 7, at 5681 (explaining that the fracking fluids may contain both formation chemicals and introduced chemicals, where the formation chemicals may include toxic metals, salts, and radionuclides, and the introduced chemicals may contain hydrochloric or muriatic acid, hydroxyethyl cellulose as gel, glutaraldehyde as biocide, petroleum distillate (or diesel) as friction reducer, ammonium bisulfate as oxygen scavenger, 2-hydroxy-1,2,3-propanetricaboxylic acid for iron control, *N,N*-dimethyl formamide as corrosion inhibitor, ethylene glycol (or 2-butoxyethanol) as scale inhibitor, and methanol-based surfactants, fluorocarbons, naphthalene, butanol, and formaldehyde); *see also* Gregg P. Macey et al., *Air Concentrations of Volatile Compounds Near Oil and Gas Production: A Community-Based Exploratory Study*, ENVTL. HEALTH, Oct. 30, 2014, at 11 (discussing the potential effect of benzene, a known human carcinogen, as chronic exposure to benzene increases the risk of leukemia, while benzene exposure increases the risk of birth defects and its respiratory effects include pulmonary edema, acute granular tracheitis, laryngitis, and bronchitis).

39. *See* Jim Morris et al., *As drilling ravages Texas' Eagle Ford Shale, residents "living in a Petri dish," in* BIG OIL, BAD AIR: FRACKING THE EAGLE FORD SHALE OF SOUTH TEXAS 10, 17 (Feb. 18, 2014), https://www.rjionline.org/downloads/big-oil-bad-air (citing Aaron Bernstein, associate director of the Center for Health and the Global Environment at Harvard University, saying that "[s]cientists 'really haven't the foggiest idea' how oil and gas development affects public health.").

40. *See* Jonathan R. Nash & Richard L. Revesz, *Grandfathering and Environmental Regulation: The Law and Economics of New Source Review*, 101 NW. U. L. REV. 1677, 1678 (2007).

EPA is required to set air emissions standards, called National Ambient Air Quality Standards, for specific air pollutants named "criteria pollutants," which are dangerous to public health and welfare.[41] Currently, there are only six criteria pollutants subject to these standards: carbon monoxide, nitrogen dioxide, sulfur dioxide, ozone, particulate matter, and lead.[42] In accordance with the standards set by the EPA, states have to submit their own State Implementation Plans, showing how they individually meet the National Ambient Air Quality Standards.[43] In turn, the EPA has the authority to step in and implement these standards in states if such State Implementation Plans are deemed inadequate.[44] As such, the CAA effectively provides the EPA with federal environmental regulation powers over the states.

In addition, the EPA has the authority under Section 112 of the CAA to regulate "hazardous air pollutants," which are toxic substances known or suspected to cause serious adverse health effects.[45] To do so, the EPA issues technology-based standards for major sources and certain area sources.[46] "Major sources" are stationary sources, which emit or have the capability to emit at least ten tons per year of one particular hazardous air pollutant, or at least twenty-five tons per year of a combination of hazardous air pollutants.[47] An "area source" is any stationary source that is not a major source.[48] With respect to major sources, the EPA is required to establish emissions standards that require the maximum degree of reduction in emissions of hazardous air pollutants.[49] These emis-

41. Robert R. Nordhaus, *Modernizing the Clean Air Act: Is There Life After 40?*, 33 ENERGY L.J. 365, 368, 368 n.13 (2012).

42. 40 C.F.R. §§ 50.1–50.18 (2014). Under § 109(d)(1) of the CAA, the EPA must review and revise air quality criteria and NAAQS every five years. 42 U.S.C. § 7409(d)(1)(B) (2014).

43. *See* Kaitlyn R. Maxwell, *Eroding the Public's Right to Clean Air: Examination of the Hazardous Air Pollutants Exemption for Natural Gas Drilling Under the Clean Air Act*, 21 B.U. PUB. INT. L.J. 153, 161 (2011).

44. *See, e.g.*, 42 U.S.C. § 7410 (2014); U.S. ENVTL. PROT. AGENCY, ACTION FOR ENVIRONMENTAL QUALITY: STANDARDS AND ENFORCEMENT FOR AIR AND WATER POLLUTION CONTROL 16 (1973).

45. 42 U.S.C. § 7412 (2014). Section 112 of the CAA specifies more than 100 hazardous pollutants (188) and provides the EPA authority to establish emission standards or National Emissions Standards for Hazardous Air Pollutants.

46. *See id.*

47. *Id.*

48. *Id.*

49. *See id.*

sions standards are called "maximum achievable control technology" standards.[50] The EPA is then required to review these standards eight years after issuance to reassess the risk associated with each source category and to revise the corresponding standard whenever necessary.[51]

With respect to criteria pollutants, in response to concerns over the emissions of atmospheric pollutants from the shale oil and gas sector and their potential impact on air quality, in April 2012, the EPA issued new source performance standard rules under § 111(b) of the CAA,[52] which included the first regulations of air emissions associated with hydraulically fractured oil and natural gas wells.[53] These new rules stemmed from WildEarth Guardians' lawsuit against the EPA under section 304(a)(2) of the CAA because the EPA had failed to review the new source performance standards and the major source air toxic standards for the oil and natural gas industry.[54] One of EPA's stated goals by implementing these newly issued standards was to significantly reduce the amount of toxic chemicals released during shale oil and natural gas production.[55]

Under the current law, any state having shale gas development is expected to submit its State Implementation Plans to the EPA before such state can regulate its shale oil and gas facilities.[56] As such, these state agencies implement federal rules in addition to state rules and state regulations incorporate the federal minimum requirements.[57] However, there are variations among the states in

50. *See id.* For each new National Emissions Standards for Hazardous Air Pollutants, the EPA is required to define the Maximum Achievable Control Technology ("MACT") standard based on the top performing facilities in that industry. *Id.*

51. *See id.*

52. 42 U.S.C. §§ 7401–671q (2014) (On April 17, 2012, the EPA finalized actions relating to the oil and natural gas production, processing, and transmission sectors as a result of the EPA review of four rules: a new source performance standard for Volatile Organic Compounds ("VOC"), a new source performance standard for sulfur dioxide ("SO_2"), an air toxics standard for oil and natural gas production, and an air toxics standard for natural gas transmission and storage.)

53. 40 C.F.R. § 60.5360–60.430 (2014); 40 C.F.R. § 63.760–63.779 (2014).

54. WildEarth Guardians v. Johnson, No. 1:09–cv–00089–CKK (D.D.C., filed Jan. 14, 2009). This lawsuit and related litigation resulted in the court issuing a consent decree compelling the EPA to prepare proposed rules regulating fracking emissions standards by July 2011, and further requiring the EPA to issue the final rules no later than April 2012. *See also Overview of Final Amendments to Air Regulations for the Oil and Natural Gas Industry: Fact Sheet*, U.S. ENVTL. PROT. AGENCY (2012), http://www.epa.gov/airquality/oilandgas/pdfs/20120417fs.pdf [hereinafter *EPA Final Amendments to Air Regulations*] (providing an overview of the EPA's response to this consent decree).

55. *See EPA Final Amendments to Air Regulations*, *supra* note 54.

56. *See generally* Hannah Wiseman, *Fracturing Regulation Applied*, 22 DUKE ENVTL. L. & POL'Y F. 361 (2012).

57. *See* Rachael Rawlins, *Planning for Fracking on the Barnett Shale: Urban Air Pollution, Improving Health Based Regulation, and the Role of Local Governments*, 31 VA. ENVTL. L.J. 226, 288 (2013).

the assessment of violations and the following enforcement procedures.[58] As an illustration, the EPA and the states may regulate oil and gas production facilities via permitting or other authorization mechanisms depending on the amount of emission these facilities produce.[59] There are several permitting programs with air emission thresholds that vary by program and location.[60] In some circumstances, however, large oil and gas producers are able to circumvent certain threshold-based permitting systems by apportioning their production facility into multiple components, each emitting less than the threshold.[61] Furthermore, in some states like Texas, the shale gas industry is operated with little oversight and some local governments are preempted from participating in programs related to air emission in urban areas.[62]

B. *The air emissions data gap*

1. *Emissions factors*

In order to provide regulations related to air emissions from the shale oil and gas industry, the EPA is using a complex methodology[63] based on estimations of the pollutants that may be released into the atmosphere. Estimations are not actual data and this could become a challenge for the EPA in terms of the decisions it has to make in relation to the air emissions released by the production of shale oil and gas.

More particularly, in a February 2013 report, the EPA Office of the Inspector General ("OIG") warned the Assistant Administrator for Air and Radiation and the Acting Assistant Administrator for Research and Development of the need to improve air emissions data in order to be able to provide accurate and effective decisions regarding the regulation of air emissions associated with the oil and gas industries.[64] In their response, both branches of the EPA agreed with most of the OIG's recommendations and further pro-

58. *See* Wiseman, *supra* note 56, at 378 (noting that states do not automatically enforce a regulation when it is violated, which results in disparities among states).
59. *See* Rawlins, *supra* note 57, at 268–69.
60. *Id.* at 271.
61. *See* Morris et al., *supra* note 39, at 25.
62. *See* Rawlins, *supra* note 57, at 295, 299.
63. *See EPA Needs to Improve Air Emissions Data*, *supra* note 2, at 10.
64. *See id.* at 1.

posed a series of corrective actions that would be implemented between 2014 and 2019.[65] These corrective actions, which were accepted by the OIG, are mostly focused on the development of "emission factors," which are derived from information collected from multiple facilities and used by the EPA to estimate emissions.[66] As the OIG noted, however, the complexity and unpredictability of the emissions generated by hydraulically fractured oil and natural gas wells may not be fully and accurately represented by such emissions factors.[67]

More particularly, an emissions factor is a number representing the relationship between the quantity of a pollutant released into the atmosphere and the activity generating such pollutant.[68] The general equation for emissions estimation used by the EPA is: "E = A x EF x (1-ER/100)," where E stands for emissions; A stands for activity rate; EF stands for emissions factor; and ER stands for overall emissions reduction efficiency.[69] The emissions factors are "usually expressed as the weight of the pollutant divided by a unit" corresponding to the activity generating the pollutant (e.g., amount by weight of particulate emitted per amount by weight or volume of energy source consumed).[70] Thus, these factors are only estimated values relating the quantity of a pollutant with its associated activity upon its release into the atmosphere. Using these factors helps give a representative estimation of the emissions produced from various sources of air pollution.[71] However, these values are only estimated and their worth depends on the quality of the original data, which may be obtained either via direct or remote measurement methods.[72]

In this respect, the EPA itself recognizes that the air emissions data resulting for these emission factors are of questionable quality because they are based on deficient or inadequate original data.[73] For example, states have to submit pollutant emissions data into a

65. Memorandum from Gina McCarthy, Assistant Adm'r, Office of Air & Radiation and Lek G. Kadeli, Principal Deputy Assistant Adm'r, Office of Research & Dev., to Arthur A. Elkins Jr., Inspector Gen., Office of the Inspector Gen. (Apr. 18, 2013) (on file with author) [hereinafter Memorandum from Gina McCarthy].

66. Memorandum from Arthur A. Elkins Jr., Inspector Gen., Office of the Inspector Gen. to Gina McCarthy, Assistant Adm'r, Office of Air & Radiation and Lek G. Kadeli, Principal Deputy Assistant Adm'r, Office of Research & Dev. (May 1, 2013) (on file with author).

67. *See EPA Needs to Improve Air Emissions Data*, *supra* note 2, at 5, 6.

68. *See Emissions Factors and AP 42, Compilation of Air Pollutant Emission Factors*, U.S. ENVTL. PROT. AGENCY (2014), http://www.epa.gov/ttnchie1/ap42/.

69. *Id.*

70. *Id.*

71. *See id.*

72. *See EPA Needs to Improve Air Emissions Data*, *supra* note 2, at 5.

73. *See id.* at 12.

database (National Emission Inventory), which is run by the EPA.[74] In particular, the EPA has only received emissions data for non-point oil and gas sources from nine states, and no data at all has been received in relation to evaporation ponds, which are locations where large quantities of wastewater from the extraction of shale oil and gas are stored and evaporated.[75] As a result, the current emissions factors used by the EPA to implement its rules and assess the impact of the oil and gas industry on human health and the environment are of limited quality and quantity.

Furthermore, the EPA has not demonstrated to the satisfaction of the OIG that it is ready to implement a comprehensive strategy for improving emissions data for the shale oil and gas sector.[76] According to the OIG report, the EPA did not anticipate the tremendous growth of the shale oil and gas industry, which should make an accurate accounting of emissions data especially important, as the EPA's task is to regulate air emissions from this growing industry.[77] The OIG report further urges the EPA to develop a system to improve the quality of its air emissions data, and notes that the agency is conducting field studies to develop new measurement methods.[78] However, the use of emissions factors and other modeling tools in order to estimate the air emissions from the shale oil and gas sectors are still prominent in the EPA's plans, and the gathering of actual data is limited or nonexistent in view of the high cost of collecting real data versus providing even more estimates for these air pollutants.[79] Such use of emissions factors or modeling tools for estimating various emissions points is far removed from obtaining first hand empirical data, which should be the preferred methodology when evaluating a young industry which is already lacking data.

2. *Actual air emissions data*

In the face of such a small amount of actual air emissions data gathered by the EPA in relation to the shale oil and gas development, community-based monitoring near such facilities may be use-

74. *See id.* at 5.
75. *See id.* at 10, 13, 28.
76. *See id.* at 28, 29.
77. *See id.* at 1.
78. *See* id. at 21.
79. *See* Memorandum from Gina McCarthy, *supra* note 65.

ful in providing an adequate tool to assess and quantify these emissions.[80] Such independent measurements have shown that air emissions from hydraulic fracturing operations are elusive and not well-understood.[81] In particular, air emissions measurements related to the release of pollutants during the flow-back stage vary by orders of magnitude resulting in data gaps, which "limit the accuracy of state and federal emissions inventories."[82] Such data gaps also result from our lack of understanding of the extent of potential emissions from drilling, the geology, and topography of the areas that are disturbed by the extraction of shale oil and gas, or the elusive fugitive emissions.[83]

Thus, such community-based data collection efforts have effectively demonstrated the limitations of the "flawed inventories," which rely on "self-reporting and . . . outmoded emissions factors," and are currently used by the EPA to evaluate air emissions from the shale oil and gas sectors and provide associated rules and regulations.[84] In particular, some of the results of these community-based projects revealed to be significant. The distance between a well and air pollutant in high concentration were much greater than the buffer zones that states have set as appropriate distances between residences and fracking wells.[85] For example, these buffer zones range between 500 feet in Pennsylvania and 1,500 feet in some parts of Texas.[86] In contrast, the community-based data collection results showed that high concentrations of the VOC formaldehyde, which is a suspected human carcinogen and may lead to a wide range of other health issues,[87] were found at up to 2,591 feet

80. *See* Macey et al., *supra* note 38, at 1. In this multi-state air quality monitoring, residents living near shale oil and gas facilities sampled ambient air from nearby production sites after being trained by an organization specialized in such process and by using Quality Assurance/Quality Control methods as set forth by the EPA. *See id.* at 4. This article also distinguishes between *top-down* studies, which provide ambient air measurements and are said to be motivated by questions such as "identifying sources" or "estimating" emissions, and *bottom-up* approaches, which provide ground-based direct source measurements. *See id.* at 3, 4 (emphasis added).

81. *See id.* at 2.

82. *Id.*

83. *See id.* at 1, 3.

84. *Id.* at 2.

85. *See id.* at 10, 11. Setbacks or buffers may be set for reasons other than air quality concerns; however, the spacing rules of such setbacks or buffers are often designed to be protective of the public. *See id.* at 3. For example, in Colorado the setback distance is 500 feet from well to home or building, absent waiver, and 1,000 feet from well to high occupancy building, absent hearing and approval. *See id.* at 7.

86. *See* Morris et al., *supra* note 39, at 32.

87. *See* Macey et al., *supra* note 38, at 14 (specifying that state agencies and international organizations continue to lower exposure limit values and guidelines for formaldehyde).

and concentrations of benzene, one of the BTEX compounds were found at up to 885 feet from the fracking wells.[88]

Additionally, this community-based monitoring study found elevated levels of hydrogen sulfide and hexane as well as a range of other longer chain hydrocarbons in some locations.[89] This type of study emphasizes the need to collect real and actual data because shale oil and gas development requires well-researched mixtures of chemicals, which produce complex mixtures of gases around the extraction sites. Furthermore, the variations in wind pattern or the presence of subterranean fractures in the earth near the extraction sites may lead to additional or unexpected emissions. These air emissions cannot be estimated via the use of emissions factors of the conventional modeling tools used by the EPA.

Other reports have found a serious gap between the data used as a basis for the EPA's regulations and the actual data collected near fracking sites.[90] Therefore, by proposing to provide more estimations and modeling of air emissions data in lieu of attempting to gather actual data, the EPA's response to the OIG report is mostly inadequate and insufficient in order to implement the goal of significantly reducing the amount of toxic chemicals released during shale oil and gas production. Some states and some of the industry are providing emissions or activity data to the EPA to update its national inventory of greenhouse gases.[91] However, "[u]ncertainties in this inventory approach are illustrated by a series of methodological changes that [the] ... EPA implemented during the past four years to estimate [methane] emissions from natural gas systems."[92] Two recent scientific studies have both found that the EPA approach resulted in underestimating methane emissions by about fifty percent.[93]

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88. *Id.* at 11.

89. *Id.* at 14 (explaining how one sample in Wyoming contained cyclohexane, heptane, octane, ethylbenzene, nonane, and 1,2,4-trimethylbenzene, for example).

90. *See* Morris et al., *supra* note 39, at 21. This source cites the above-referenced OIG report titled *EPA Needs to Improve Air Emissions Data*, which states that the National Emissions Inventory used by the EPA "likely underestimates" the air emissions from the shale oil and gas production. *EPA Needs to Improve Air Emissions Data*, *supra* note 57, at 3.

91. *See* Moore et al., *supra* note 20, at 8351.

92. *Id.*

93. *See id.* (explaining that the missing emissions in the inventory could be explained by larger emissions from oil and gas production and processing).

IV. POSSIBLE SOLUTIONS

A. *The shale oil and gas industry and the regulators presently need more empirical air emissions data to reduce health and environmental risks*

The data that the EPA intends to use to generate emissions factors does not appear to adequately represent the actual emissions produced by hydraulically fractured natural gas wells. Thus, more actual air emissions data is needed prior to the implementation of environmental policies based on such data. The oil and gas industries are not new industries. Simply because a new process used by these industries has resulted in enormous economic growth does not mean that the consequences of such growth in terms of potential pollutants emitted by the entire sector should be overlooked at a national level.

Two recent reports, one from the Southwest Pennsylvania Environmental Health Project, published in *Reviews on Environmental Health,*[94] and the other from the Center for Sustainable Development at the University of Texas, published in the *Virginia Environmental Law Journal,*[95] further illustrate the current lack of knowledge and understanding about the processes used in this growing industry sector.[96] If the impacts of the shale oil and gas industry on public health and the environment are not fully understood, these impacts become difficult to accurately assess and properly regulate. Thus, in order to properly control air emissions from natural gas production facilities, a better understanding of the processes used by the industry is required, which in turn implies the need for the submission and evaluation of more actual atmospheric data from a wide array of locations near or around actual production sites.

The recent growth in shale gas production is still small compared to what some estimates show will be an exponential growth of this industry in the coming decades.[97] Therefore, actual experimental data should be gathered now in order to assess with some degree of certainty what pollutants, and in what amount, are actually emitted in the atmosphere by the shale oil and gas industry. Otherwise,

94. *See generally* David Brown et al., *Understanding Exposure from Natural Gas Drilling Puts Current Air Standards to the Test*, 29 REV. ENVTL. HEALTH 277 (2014).
95. *See* Rawlins, *supra* note 57, at 303.
96. *See id.*
97. *See* Field et al., *supra* note 6, at 955.

such tasks may become even more difficult to achieve when this industry completely matures because of its increased political power and the difficulty in changing habits.

B. *The shale industry, the local governments, and the states as the primary regulators*

The shale oil and gas industries have not produced any cataclysmic environmental or human disaster and, in view of the recent rise in demand for these sources of energy, the EPA appears to have properly responded by implementing new standards, adapting to the industry's market-based growth by investing in human resources, and planning additional and improved procedures to monitor air emissions from oil and gas production to ensure that the industry is regulated safely, responsibly, and cost-effectively.[98] In addition, many states and municipalities have taken regulatory steps to develop a safer shale industry by balancing economic and environmental concerns.[99] According to this approach, those who are the most invested in having a safe environment are often those living closest to the production sites and they are often more apt to evaluate and address any problem related to the industry.[100] In this sense, many states have started to conduct air quality studies and to collect air emissions data.[101]

Some have argued that the "EPA's attempts to assess the risks of hydraulic fracturing . . . could result in needless additional regulation of a practice that [is] view[ed] as safely regulated by [the] states."[102] Others have found that the current implementations by the EPA, which estimate air emissions using modern modeling based on actual measurements, provide a relatively accurate representation of the effect of local gas wells onto their surrounding environment.[103]

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98. *See* Thomas O. McGarity, *When Strong Enforcement Works Better than Weak Regulation: The EPA/DOJ New Source Review Enforcement Initiative*, 72 MD. L. REV. 1204, 1206–07 (2013) (discussing different approaches of environmental regulations in the context of the initiatives taken by the EPA and the Department of Justice in relation to enforcing the CAA new source review requirements of 1990).

99. *See id.* at 1208.

100. *See* Smith, *supra* note 14, at 142 (questioning the effectiveness of oversight in situations where the nearest regulatory authority is a several-hour drive from the drill site).

101. *See id.* at 147.

102. Puneet Kollipara, *Fracking Study Criticized*, CHEMICAL & ENGINEERING NEWS, July 29, 2013, at 10. *Cf.* Uma Outka, *Environmental Law and Fossil Fuels: Barriers to Renewable Energy*, 65 VAND. L. REV. 1679, 1715–16 (2012) (outlining that the industry opposes the 2012 rule under CAA §§ 111 and 112 because of the high cost of technological and administrative compliance with emissions controls).

103. *See* David T. Allen, *Atmospheric Emissions & Air Quality Impacts from Natural Gas Production & Use,* 5 ANN. REV. CHEMICAL & BIOMOLECULAR ENGINEERING 55, 67 (2014)

The EPA has also been strongly criticized for making undemocratic decisions when non-elected agency officials are exercising lawmaking authority by interpreting the CAA, and imposing regulations on the states based on the agency's interpretation rather than allowing the people's representatives to make decisions.[104] In this context, one may ask why self-regulation by a reasonable energy sector combined with modern scientific modeling methods used by state agencies to monitor emissions levels would not be sufficient to keep a safe and healthy environment around shale production facilities. One of the possible drawbacks of such approaches may be that rival states would not be able to agree when emissions are not necessarily contained in one state. Furthermore, an honor system based on self-reporting by the industry of excessive atmospheric emissions of pollutants seems inherently inconsistent with the goals of the economic enterprise. It may well be that an industry could police itself and act with an open door policy vis-à-vis its regulators but it seems instinctively evident that "[a]s much as [one] would like to believe that [the] industry can police itself, history has shown that that has not worked without sufficient oversight."[105]

C. *A plan for the future*

In creating the EPA,[106] Congress promulgated the agency's role as "the *protector* of earth, air, land, and water" and its goal to "assure for all Americans safe, healthful, productive, esthetically and culturally pleasing surroundings."[107] In this respect, the EPA's response to the need to improve air emissions data for the oil and natural gas production sectors by further estimating and modeling such data or the "leaving it to the states" attitude may not be completely in line with the EPA Congressional Charter.

In fact, since the beginning of the economic boom in the shale oil and gas industry, these producers have been taking advantage of many regulatory exemptions owing to the strong economic need in

(providing quantitative data showing that monitored VOC emissions emanating from shale gas production sites in the Barnett region are reasonably close to their corresponding emission estimates).

104. *See* EPA v. EME Homer City Generation, L.P., 134 S. Ct. 1584, 1610 (2014) (Scalia, J., dissenting).

105. Morris et al., *supra* note 39, at 23.

106. National Environmental Policy Act, 42 U.S.C. § 4321 (1969).

107. *The Guardian: Origins of the EPA*, U.S. ENVTL. PROT. AGENCY (Spring 1992), https://www.epa.gov/aboutepa/guardian-origins-epa (describing the National Environmental Policy Act (NEPA)).

the United States for domestic energy producers.[108] This has meant that this industry has not been held to the same standards of other similar industries with respect to the emissions of atmospheric pollutants. In particular, in 1987, the EPA carried out a cost-benefit analysis of what it would take to subject the oil and gas industry to a hazardous waste standard, and found that it would be at least three times as costly as a non-hazardous waste standard.[109] Such a costly enterprise was deemed to have the potential for a chilling effect on this young industry and a federal exemption was thus approved in 1988.[110]

In addition, the EPA response to the OIG with respect to the lack of data and some of its negative responses or alternative decisions to adopt the OIG recommendations are particularly illustrative of the limitation in the agency's willingness to convincingly regulate the shale oil and gas sectors.[111] For example, the EPA recommendation is to "encourage and assist" states in submitting air emissions data instead of "ensuring" that the EPA monitor states' submissions of such data.[112] Further, the EPA response appears to mainly consist of further relying on inventories based on data that is obsolete, inaccurate or incomplete. Such a laissez-faire attitude, in conjunction with the current lack of scientific knowledge of how, when, and where actual air emissions released by the shale oil and gas producers should be measured, have strongly impaired the quality of the current data, which is the basis for the rules and regulations applied to this industry. Therefore, a new direction is needed in order to appropriately balance the needs of the energy industry with those of the people affected by it. In particular, there is a great opportunity to include more science and scientific methods at all levels of this growing industry.[113]

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108. *See The Applicability of Federal Requirements that Protect Public Health and the Environment to Oil and Gas Development: Hearing Before the H. Comm. on Oversight & Gov't Reform*, 110th Cong. (2007) (statement of Amy Mall, Natural Resources Defense Council).

109. *See* Hasemyer et al., *supra* note 19.

110. *See id.*

111. *See EPA Needs to Improve Air Emissions Data*, *supra* note 2, at 28, 29.

112. *Id.* at 29.

113. *See* Cheryl Hogue, *Changing How EPA Gets Science Advice*, CHEMICAL & ENGINEERING NEWS, May 6, 2013, at 29 (By using the phrase "all levels," it is meant that science may be used at the pre-production stage, in designing production sites and wells, in selecting chemical substances to be added to the fracking fluid; at the production stage; and at the regulation stage, in evaluating and capturing the air emissions. The inclusion of science may also be expanded at the regulation and enforcement levels.)

In this context, a recent decision[114] by the United States Supreme Court upheld the authority of the EPA over the states on the complex problem of air pollution involving multiple states.[115] In this decision, the majority gave the EPA wider discretion and responsibility to interpret the CAA and to apply the corresponding appropriate methodology.[116] This decision appears to be open to the idea of casting a broader net towards acquiring more knowledge in order to be able to properly assess the "complex problem"[117] of air pollution related to the shale oil and gas industry.

Fracking technology and its application in combination with hydraulic drilling is here to stay and no one really wants to stop its economic growth, as it has allowed the creation of thousands of jobs and the economic development of many poor geographic areas. However, there is a need to acquire a better understanding of how the shale oil and gas industry affects the environment and the health of the people around it. By taking a scientific view of such a need, it appears evident that more empirical data should be gathered and evaluated. The involvement of scientists should include not only geologists, but also chemists, engineers, environmental scientists, biologists, biochemists, and medical doctors, for example. In addition to these teams of scientists, the shale oil and gas industry, as well as local, state, and federal governments should all try to cooperate towards this goal.

In this respect, in 2014, two bills were introduced before the United States House of Representatives, the "EPA Science Advisory Board Act"[118] and the "Secret Science Reform Act."[119] Some of the goals of these two bills were to require a greater transparency by the EPA, which would have had to publicly disclose the raw data it uses in preparing scientific analyses and advice. In addition, their goals were to allow more scientists as well as the public to provide input and further the discussion started with the scientific documents drafted by the EPA Scientific Advisory Board.[120] Although these bills passed the House of Representatives, they never had a chance in the Senate, and even attached to a larger bill that would have ended up on the President's desk, a veto would have been

114. *EME Homer City Generation*, 134 S. Ct. at 1584 (In this decision, the majority recognized the enormity of the task before the EPA and emphasized the deference that should be given to such expert agency.).
115. *See id.*
116. *See id.* at 1607.
117. *Id.* at 1592.
118. H.R. 1422, 113th Cong. (2014).
119. H.R. 4012, 113th Cong. (2014).
120. *See* Hogue, *supra* note 113, at 29, 30.

highly likely.[121] The main critics of these bills, which included the Administration and the Senate majority,[122] contended that the EPA Scientific Advisory Board already possesses the expertise to make decisions, and that allowing external scientific input would only slow down a system that is already very slow.[123] These arguments are understandable, but when one considers the specific industry of shale oil and gas, which is still new and unknown, there must be a way for regulators to seek opportunities to acquire a broader and more in-depth knowledge of the overall industry.

In this sense, the role of scientists in determining the most suitable methodology should outweigh any other. The process of setting standards with respect to a highly technological industry such as the oil and gas sectors should be the result of rigorous scientific research and investigation. As such, a greater involvement of scientists in policymaking and regulation may positively affect industry compliance with any new regulation. Furthermore, in order to implement these ideas, funding allocated to studying the effects of the shale oil and gas industry should be commensurate with the significance of the risk on human health and the environment.

V. CONCLUSION

The EPA states that the need for data regarding air emissions from the shale oil and gas industry is "critical."[124] However, the means of the EPA for obtaining such emissions data are relatively weak[125] if the agency is only to "encourage" and "assist"[126] other entities such as state governments to provide data. Further, the shale oil and gas industry may not be a completely reliable party when it comes to providing accurate data. For example, several field studies conducted by the U.S. National Institute for Occupational Safety and Health ("OSHA") at shale production sites in different states revealed that employees at these facilities were exposed to levels of

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121. *See id.* at 31; *see also* Daniel Bloom, *House Passes 2 of 3 Anti-EPA Bills Facing Veto*, CQ ROLL CALL, Nov. 19, 2014, *available at* 2014 WL 6465228; Puneet Kollipara, *Environmentalists, Scientists Fret Over Republican Bills Targeting EPA Science*, SCI. (Nov. 21, 2014), http://news.sciencemag.org/environment/2014/11/environmentalists-scientists-fret-over-republican-bills-targeting-epa-science (arguing that the bills "could preclude the nomination of scientists with significant expertise in their fields" and "could drastically cut the number of studies that EPA would be allowed to use in developing rules.")

122. *See* Hogue, *supra* note 113, at 31; *see also* Bloom, *supra* note 121.

123. *See* Bloom, *supra* note 121.

124. *See EPA Needs to Improve Air* Emissions *Data*, *supra* note 2, at 28.

125. *See id.* (explaining that only nine states submitted emission data for nonpoint oil and gas sources).

126. *See id.* at 29.

respirable silica higher than the filtration capabilities of the half-face respirators provided to these employees.[127]

The states as well as the shale oil and gas industry may well have the public interest at heart with respect to accurately accounting for emissions data. However, a reasonable oversight appears to be needed to ensure that such critical data is obtained in order to improve our level of understanding of this growing sector. In this context, the goal in crafting or enforcing federal regulations related to the shale oil and gas industry should not be to impose more stringent restraints and obligations on such a young and growing industry, but to acquire more knowledge based on empirical information and data. In this respect, borrowing from the scientific method may help in deciphering and evaluating such information, and may ultimately help build a better industry while protecting human health and the environment.

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127. *See* Moore et al., *supra* note 20, at 8353 (noting that little information is available on emission of respirable silica, which comes from the proppant used in fracking).